UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Ex parte RICHARD TODD GOLDBERG

Appeal No. 2005-1221
Application No. 09/085,298

ON BRIEF

Before KIMLIN, GARRIS, and OWENS, *Administrative Patent Judges*.

OWENS, *Administrative Patent Judge*.

DECISION ON APPEAL

This appeal is from a rejection of claims 1-5, 7-10 and 13.[1]

THE INVENTION

The appellant claims methods for forming a dielectric layer, such as a gate dielectric layer, on a semiconductor substrate, wherein a portion of the semiconductor substrate is both

[1] The board previously (August 21, 2003) remanded the case to the examiner for the examiner to provide "a complete statement of the examiner's views with regard to the amount of oxygen released from the quartz tube, the time in the process when the oxygen is released, whether prior to or subsequent to the formation of silicon nitride and whether the oxygen released results in thermal oxidation of a portion of said silicon-containing structure as required by the claimed subject matter" (remand, page 3).

thermally nitridated and thermally oxidized. Claim 1 is illustrative:

1. A method of forming a dielectric layer on a silicon-containing structure, said method comprising the steps of:
providing, to a silicon-containing structure, a gas comprising a mixture of nitrogen and oxygen;
heating said silicon-containing structure to an elevated temperature greater than 700C; and
striking a plasma above said silicon-containing structure to cause thermal nitridation and thermal oxidation of a portion of said silicon-containing structure.

THE REFERENCES

Nozaki et al. (Nozaki)	4,298,629	Nov. 3, 1981
Tseng	5,643,819	Jul. 1, 1997

THE REJECTIONS

The claims stand rejected under 35 U.S.C. § 103 as follows: claims 1-4, 7, 8 and 13 over Nozaki, and claims 5, 7, 9 and 10 over Nozaki in view of Tseng.

OPINION

We reverse the aforementioned rejections.

Each of the appellant's independent claims requires providing a gas comprising a mixture of nitrogen and oxygen and striking a plasma to cause thermal nitridation and thermal oxidation.

Nozaki discloses "a method for forming an insulating film on a semiconductor body surface, wherein an insulating film of

silicon nitride is formed by direct nitridation of at least one semiconductor silicon body positioned in a direct nitridation reaction chamber, characterized in that a gas plasma of a nitrogen-containing gas is generated in the direct nitridation reaction chamber, and the semiconductor silicon body is heated to a temperature of from approximately 800° to approximately 1300°C. within the gas plasma atmosphere, thereby forming the silicon nitride film" (col. 3, lines 11-21). The disclosed nitrogen containing gases are nitrogen, ammonia,[2] hydrazine, and mixtures thereof, and the gas may include one or more of hydrogen, hydrogen chloride, halogen gas and inert gas (col. 3, lines 22-29). Nozaki wants the silicon nitride film to have a low oxygen content (col. 3, lines 3-6).

The examiner argues (supplemental answer, pages 3-4):

> Nozaki et al. discloses at column 7, lines 9-12 that a high concentration of nitrogen and a low concentration of oxygen are already present at the surface of the silicon substrate prior to a thermal processing step to form a silicon nitride dielectric layer. Similar to the thermal processing step of the instant invention which requires a temperature range of at least 700°C (see Appellant's specification, page 7, lines 6-8), the

[2]Nozaki discloses (col. 7, lines 58-62): "The ammonia (NH_3) gas preferably has a purity of 99.99% or higher. When ammonia gas having such purity is used as the nitrogen containing gas, the oxygen concentration of the silicon nitride film can be reduced to less than 10 molar %."

> thermal processing step of Nozaki et al. is carried out at approximately 800-1,300°C (see Nozaki et al., col. 7[sic, 5], lines 2-6). Therefore, because Nozaki et al. has shown the existence of oxygen and nitrogen prior to the thermal processing step, thermal nitridation and thermal oxidation of the silicon substrate must occur at the temperature range as shown. Nozaki et al. further discloses in TABLE 1 that oxygen in various concentrations are [sic] still present in the silicon nitride dielectric layer after the thermal processing.

Column 7, lines 9-12 of Nozaki relied upon by the examiner discloses:

> It will be apparent from FIG. 5 that silicon is combined with a high concentration of the nitrogen and a low concentration of oxygen at the surface of the FZ [floating zone] substrate subjected to the direct thermal nitridation. Accordingly, a silicon nitride film containing a low concentration of oxygen can be produced according to the method of the present invention.

As indicated by the paragraph preceding this portion of Nozaki, figure 5 shows the results of an Auger analysis of a silicon nitride film that already has been formed. Thus, contrary to the examiner's argument, the portion of Nozaki relied upon by the examiner does not show the existence of oxygen prior to thermal nitridation. Regarding the examiner's argument that Nozaki discloses in table 1 that oxygen is present in the silicon nitride films after thermal nitridation, Nozaki teaches that this oxygen "includes the oxygen which is adsorbed on the surface of

the silicon nitride films as foreign matter" (col. 6, lines 20-22). The examiner has not established that this adsorbed oxygen foreign matter, or any other oxygen present, was in gaseous form prior to the thermal nitridation or was in a form capable of causing thermal oxidation.

The examiner argues:

> Nozaki et al. fails to specifically show the nitrogen gas also include[s] oxygen or wherein plasma stricken above the silicon containing structure also causes thermal oxidation of a portion of the silicon containing structure. However, since oxygen is present in the quartz tube, it would have been obvious to one having an ordinary skill in the art at the time the invention was made that the oxygen from the quartz tube would combine with the nitrogen gas resulting in a gas comprising a mixture of nitrogen and oxygen. Furthermore, since the general conditions of Nozaki et al. are similar to that of the instant invention, it would have been obvious to one having an ordinary skill in the art at the time the invention was made that the portion of the silicon containing structure that was thermally nitrided would have been thermally oxidized. [answer, page 3]
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> * * *
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> Nozaki et al. teaches the use of a nitrogen-containing gas along with a quartz tube that contains oxygen. Inherently, the oxygen from the quartz tube would incorporate with the nitrogen-containing gas resulting in a gas comprising a mixture of nitrogen and oxygen. As a result, thermal nitridation and thermal oxidation of the underlying structure would occur upon subsequent heating of the silicon-containing structure in the gas mixture of nitrogen and oxygen to an elevated temperature. [answer, pages 5-6]

The examiner is relying upon the oxygen from Nozaki's quartz tube (col. 2, lines 35-38) inherently causing thermal oxidation during the thermal nitridation.

When an examiner relies upon a theory of inherency, "the examiner must provide a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic *necessarily* flows from the teachings of the applied prior art." *Ex parte Levy*, 17 USPQ2d 1461, 1464 (Bd. Pat. App. & Int. 1990). Inherency "may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient." *Ex parte Skinner*, 2 USPQ2d 1788, 1789 (Bd. Pat. App. & Int. 1986).

Nozaki's oxygen, the appellant argues, could be insufficient to oxidize the silicon, or could be produced too late in the process, after the silicon nitride has already formed, to reach and oxidize the silicon, or could be present in the form of quartz particles or molecules released from the reaction tube itself, rather than as oxygen in a form that can oxidize, or has oxidized, the silicon (supplemental reply brief, page 4). The appellant points out Nozaki's disclosure that the oxygen in

table 1 "includes the oxygen which is adsorbed on the surface of the silicon nitride films as foreign matter" (col. 6, lines 20-22), and argues that this disclosure is sufficient to show that the oxygen in the nitride film did not necessarily oxidize the underlying silicon. *See id.* These are plausible arguments, and the examiner has not provided evidence or technical reasoning which shows that the oxygen from Nozaki's quartz tube necessarily is in gaseous form or a form capable of causing thermal oxidation.

The examiner argues that Wolf et al., *Silicon Processing for the VLSI Era, Volume 1 - Process Technology* (2nd ed. 1986), discloses forming a nitrided oxide layer from N_2O, NO, or a mixture of those gases with O_2 (supplemental answer, page 4), but the examiner has not established that Nozaki uses Wolf's method.

For the above reasons we conclude that the examiner has not carried the burden of establishing a *prima facie* case of obviousness of the appellant's claimed invention.[3]

[3] The examiner does not rely upon Tseng for any disclosure that remedies the above-discussed deficiency in Nozaki.

DECISION

The rejections under 35 U.S.C § 103 of claims 1-4, 7, 8 and 13 over Nozaki, and claims 5, 7, 9 and 10 over Nozaki in view of Tseng, are reversed.

REVERSED

EDWARD C. KIMLIN)
Administrative Patent Judge)
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BRADLEY R. GARRIS) BOARD OF PATENT
Administrative Patent Judge) APPEALS
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